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(Installations and
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Solar Thermal Radiant Heating at Pohakuloa Training Area

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Technology Transition – Supporting DoD Readiness, Sustainability, and the Warfighter

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Energy Situation in Hawaii

- Electricity rates for Pohakuloa Training Area were \$0.26/kWh in 2009 and \$0.35/kWh in 2008.
- In remote locations such as Hawaii, fossil fuel must be imported, resulting in:
 - High utility prices
 - Security risk for transportation.
- Hawaii Electric Light Company (HELCO) imports oil as majority fuel source:

HELCO's 2008 Fuel Mix	
Fuel Sources	Percentage
Oil	68.0%
Geothermal	18.8%
Hydro	2.9%
Wind	10.3%

Pohakuloa Training Area

- Pohakuloa Training Area (PTA) is a military training complex for soldiers and marines.
 - Hosts up to 2,000 +/- at one time
 - Can host up to 75,000 +/- personnel in a year
 - Largest DoD Live Fire Training installation in Hawaii
- Located in a rural area between two volcanic mountains.
 - Near the center of the island of Hawaii
 - Approximately 6,800 ft elevation (PTA Base Camp)
 - Temperatures can drop below freezing at night

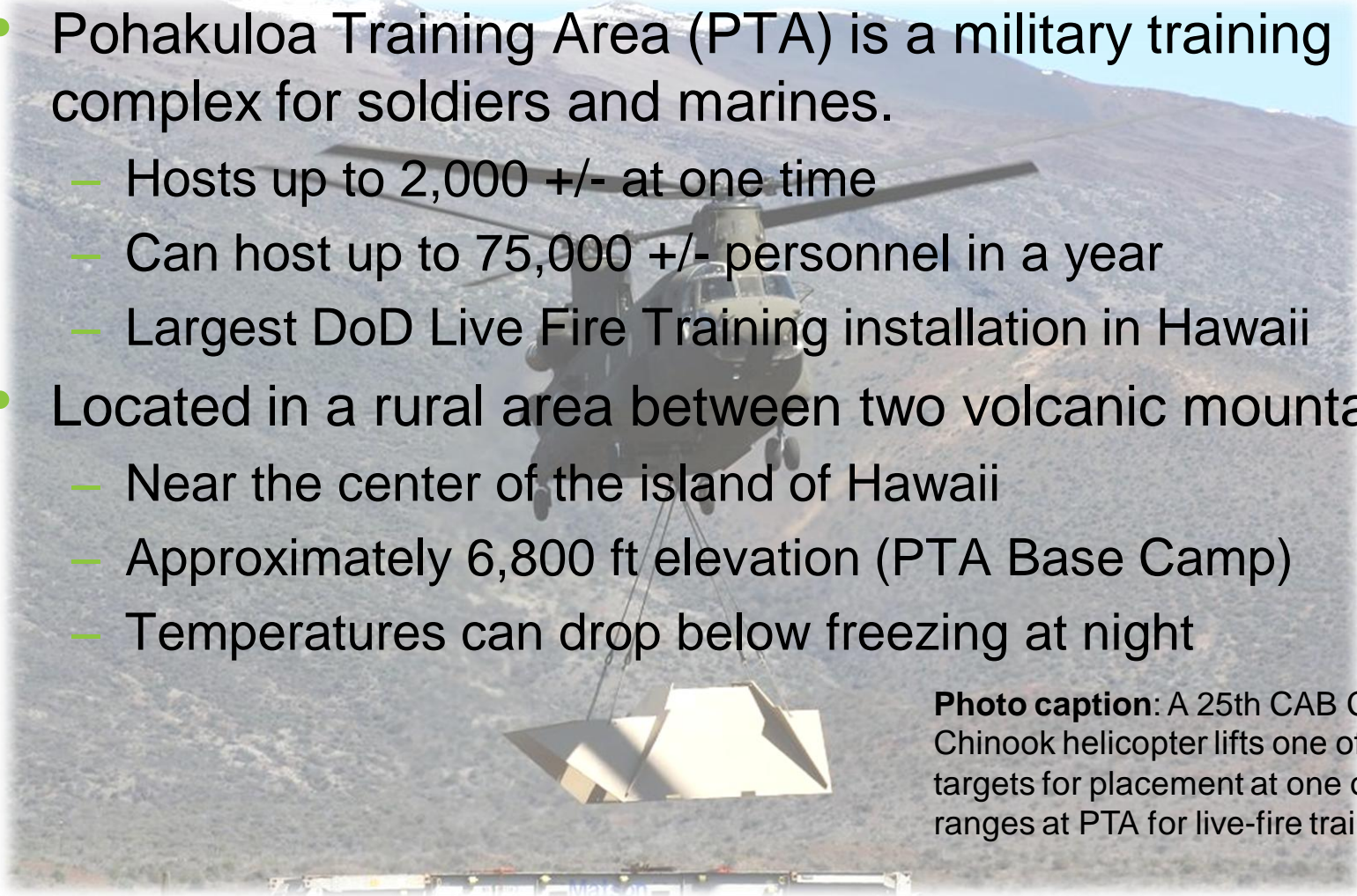


Photo caption: A 25th CAB CH-47D Chinook helicopter lifts one of 28 “EOD-T” targets for placement at one of several ranges at PTA for live-fire training.

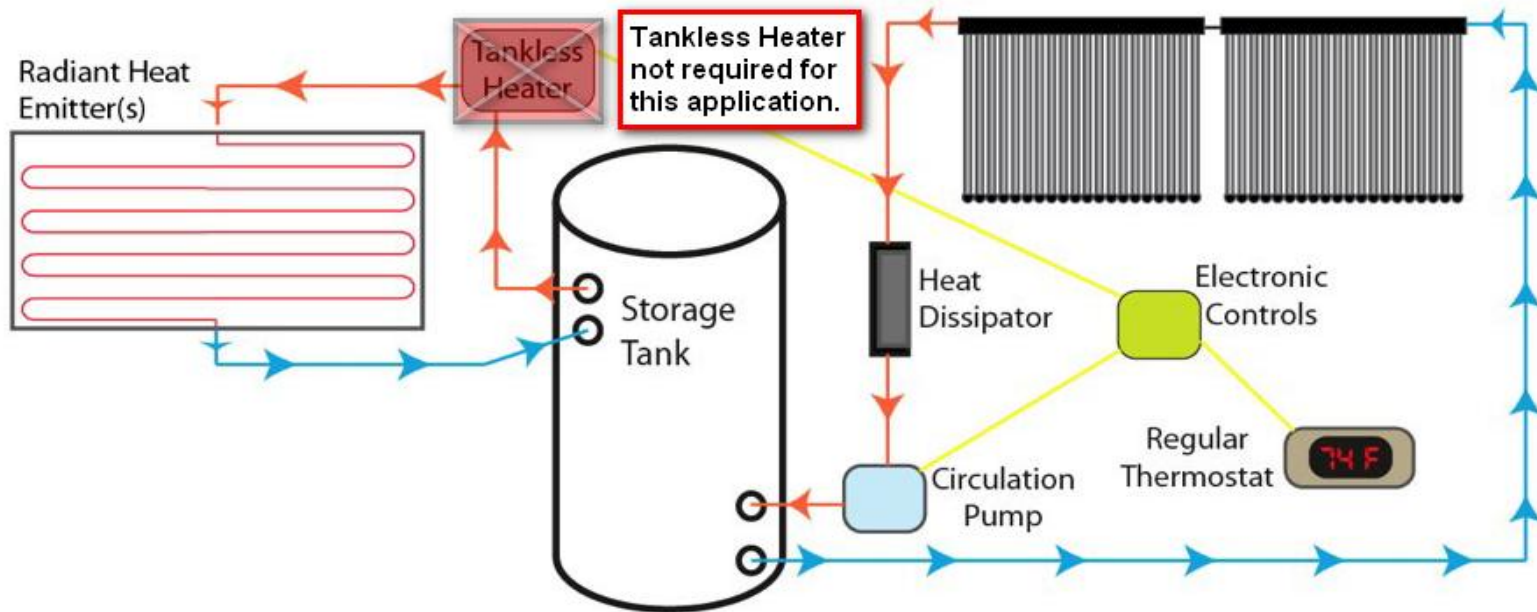
PTA Billet Buildings

- Newly constructed Billet Buildings sleep 60 people each:
 - Each building is 2,000 square feet
 - Heating and cooling is provided with electric heat pump
 - No water; latrines are provided in nearby separate building.
- Solar thermal radiant heat flooring project will combine solar thermal hot water system with in-floor radiant heating.
 - Flooring heat only; no domestic water.
 - Flat plate collectors combined with water storage tank will collect and store the sun's energy during the day.
 - System will provide heat to Billet Building 227C at night.



PTA Billet Buildings 227A, B, and C

What IS a solar thermal radiant heat flooring system?



- Main components are solar collectors, a storage tank, radiant heat emitter (flooring system), circulation pumps, thermostat, electronic controls, and a heat dissipator.
- This system could be modified to include domestic water heating.

System Design Approach

- Step 1: Determine the peak hourly load for the building in BTU/hr.
 - Based on expected lowest outside temperature.
- Step 2: Determine the thermal storage required for the highest calculated daily load in BTU/day.
 - Use local weather data and energy modeling software.
 - Peak hourly load is summed over 24 hours.
- Step 3: Size the solar collector array.
 - Use BTU/day calculated in Step 2.
 - Use solar collector rating output in BTU per day.
 - Determine number of collector panels necessary.
- Step 4: Choose the system type.
 - Options include open loop, closed loop, drainback, etc.

System Design Approach (continued)

- Step 5: Plan the array layout.
 - Options vary depending on system type (closed loop, etc.).
 - Layout determines plumbing configuration.
- Step 6: Size the storage tank and heat exchangers.
 - Amount of fluid and storage tank size can be calculated.
 - Heat exchanger only required for domestic water heating.
- Step 7: Size and select the floor heating system.
 - Using peak hourly heat load, determine circuiting of heated water tubing and floor panels (loop layout).
- Step 8: Size the pump skid and ancillary equipment.
 - Calculate head losses and flow rate to size pump(s).
 - Select expansion tank, relief valves, check valves, heat dissipation equipment, etc.

Daily Thermal Storage Calculations

- To determine the daily thermal storage for heating systems (Step 2), need to use energy simulation model such as Trane TRACE™.
 - TRACE is a design/analysis tool for HVAC professionals used to calculate peak cooling and heating loads, evaluate energy savings, and optimize the design of HVAC systems.
- Model requires local weather information files.
 - Called TMY2 files, these are data sets of hourly values of solar radiation, temperature, humidity, and cloud cover for a 1-year period.
 - Produced and published free by National Renewable Energy Laboratory (NREL).
 - TMY2 files are often applicable for a large area.

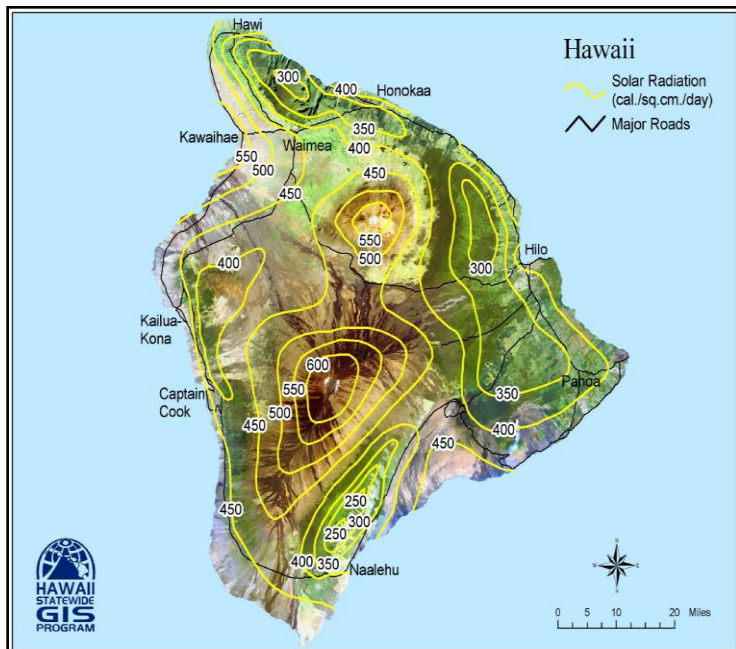
PTA TMY2 Data File

- Hawaii Island has 12 distinct climate zones, but no TMY2 data file for PTA.
- Because there is no TMY2 data file applicable for the micro-climate at PTA, a unique TMY2 data set had to be created.
- TMY2 data compiled from two sources:
 - Solar radiation data came from a State University of New York (SUNY) model for nearby Bradshaw Army Airfield at PTA.
 - Weather data came from one of four small weather stations on PTA grounds monitored by PTA firemen.
 - PTA Range 17 station is closest to site location and elevation.
 - Data only recorded for one year at time; most TMY2 data files are averaged over multiple years.

PTA TMY2 Data File (continued)

PTA Solar Data

- Using the SUNY data mean estimate for each hour gives average solar radiation = $481 \text{ cal/cm}^2/\text{day}$.



PTA Weather Data

- PTA Range 17 data was compiled and minor data gaps were filled in by interpolation.
- A pivot table was created to summarize the 8,760 hours of data into monthly “Design Days”.
- Next, data was formatted and SUNY solar radiation data was added.
- MS Excel file was turned into text file, then converted to TMY2 file for input into TRACE.

PTA Heating System Design

- Data loggers are currently in place at PTA to record indoor and outside temperatures and relative humidity.
 - More data loggers will be added, including solar radiation measurement.
 - Additional data will be used to validate PTA TMY2 data file.
 - If successful, we may be able to publish this TMY2 data file.
- After creating TMY2 file, TRACE output for coldest month showed a daily heating load of 256,000 BTU/day.
 - First calculations for thermal storage were based on a 75 °F space set point and an average low temperature of 32.4 °F.
 - Revised calculations are based on a 70 °F space set point and an adjusted low temperature of 23 °F.
 - The peak design load for this space set point temperature is 35,908 BTUh.

PTA Heating System Design (continued)

- Performed market analysis to compile information for various components of system
 - Radiant heat flooring panels
 - PEX tubing
 - Solar collector panels.
- Sizing the array: Using thermal storage of 256,000 BTU/day and 4' x 10' flat panel collectors with output of 35,600 BTU/day, seven (7) collectors are necessary for 227C bldg.
- Selected closed loop system with heat transfer fluid.
- Solar collector plates will be arranged side-by-side on the south-facing pitch of roof.
 - Racked at 30° angle to maximize winter sun.



Flat plate solar collectors

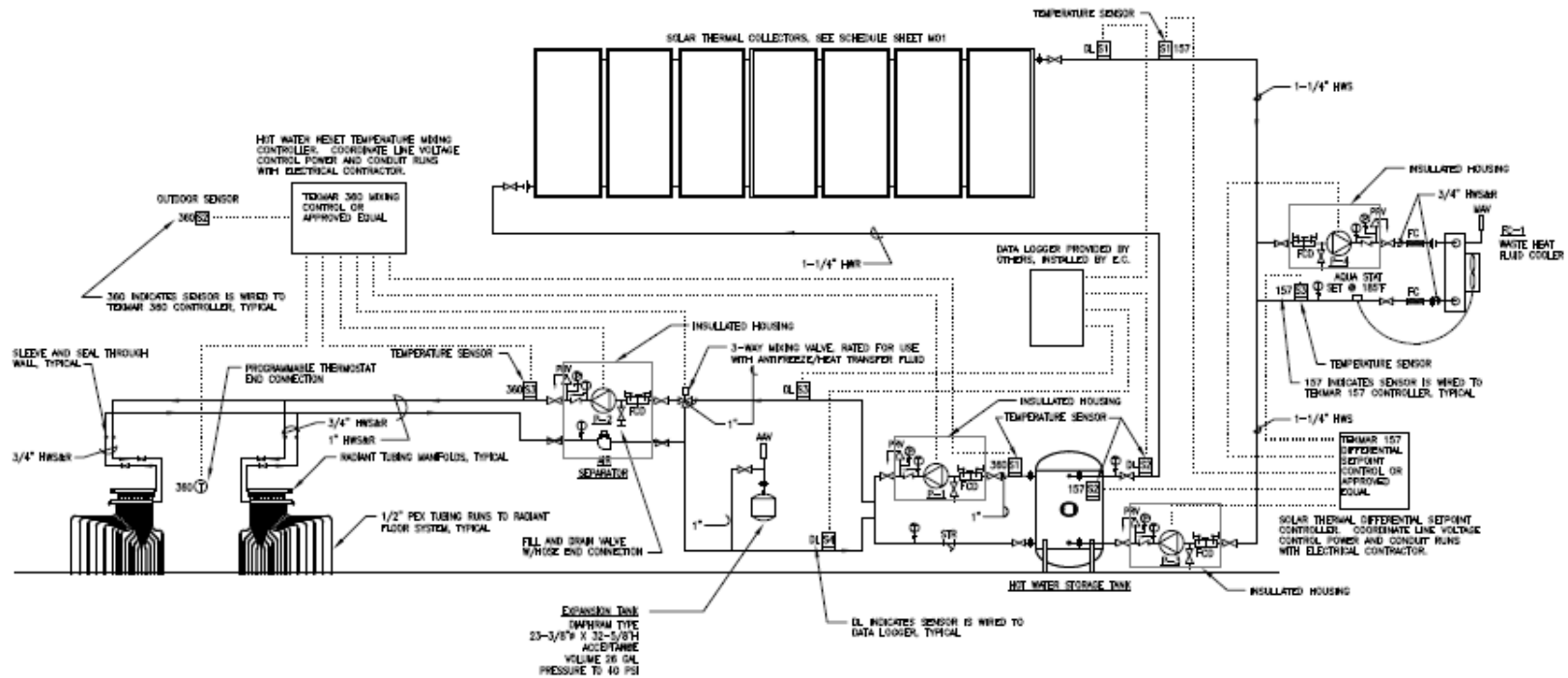
PTA Heating System Design (continued)

- Flow rate for system will be approximately 8 gallons/minute.
- Based on flow rate and number of collectors, the storage tank should be approximately 585 gallons.
 - Selected vertical orientation for smaller footprint and better stratification.
- Selected retro-fit flooring panels to be installed over existing concrete floor.
 - One inch thick floor panels with channels cut for tubing.
- Consulted with Roth Industries to complete a Radiant Heating Design Summary.
 - Piping length will be approximately 3,780 feet for Bldg 227C.



Roth flooring panel

PTA System Design Schematic



GENERAL NOTES:

1. ALL PIPING SHOWN IS 3/4" COPPER UNLESS NOTED OTHERWISE.
2. PROVIDE FIVE REDUCERS AND UNIONS AS REQUIRED BY MANUFACTURER.
3. PROVIDE RLL SYSTEM FOR PROBLEME GLYCOL SOLUTION.
4. REFER TO SHEET #01 FOR SYMBOLS, ABBREVIATIONS, DETAILS AND NOTES.
5. SLOPE PIPING TO ALLOW DRAINING OF SYSTEM.

NOTE:
ALL EQUIPMENT AND PILING IS NEW UNLESS NOTED OTHERWISE

MECHANICAL – PIPING SCHEMATIC

SCALE: NTS

Rebates and Grants

- A variety of tax credits, rebates, and grants were explored, but only one option is available for this project.
- Hawaii Electric Company's (HECO's) Hawaii Energy Efficiency Program.
 - This project falls under the Customized Business Incentive Rebate Program.
 - For customers under commercial rate schedules that are not covered by other utility incentive programs.
- To qualify, the Customized Incentive Application and the Worksheet must be submitted to HECO.
 - Include supporting information such as layouts, drawings, technical attachments, and/or vendor literature.
- Program approval is required prior to the start of work.

Rebates and Grants (continued)

- Application is being prepared for submittal to HECO.
- The rebate levels for the Customized Incentive Program are as follows:

Rebate Levels	Existing Facilities	New Construction
First Year Energy Savings	\$0.05 per kWh saved	\$0.06 per kWh saved
On-Peak Utility Demand Reduction	\$125 per kW reduced	\$125 per kW reduced

- Still unsure how rebate is paid out.

PTA Project Status

- System design is complete.
- Structural analysis to evaluate potential wind load is being performed.
- Request for Proposals submitted to General Contractors.
- Bids turned in and being evaluated.
 - Contract will be awarded soon to selected GC
- HECO Custom Rebate application is being prepared for submittal.
- Installation scheduled to begin September 1, 2010.
 - Installation to be complete by October 15, 2010.

Path Forward

- Following installation, system will be monitored for one year as part of demonstration/validation (dem/val).
- Following dem/val, a life cycle cost and performance evaluation of the system will be completed.
- Stay tuned for further development...





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